

Location-based applications using analog maps for sustainable local tourism information services

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Abstract: Conventional paper-based tourist maps are still being created and provided by local tourism organizations, as they have advantages in representing highly specified and contextual information, although limited by the static media. This research proposes to establish a sustainable ecosystem for the local tourist maps to utilize them in mobile devices to benefit from the location-aware environment, interactivity and feedback data. A low-cost solution of providing tools are realized to georeference the maps and integrate multimedia sightseeing information owned by local tourism organizations for developing mobile tourism applications. The Processes for map georeferencing and content integration, as well as the design principles of the mobile tourism applications, are discussed in details. In cooperation with university campuses and local tourism organizations, experimental applications are implemented to evaluate the functionality and usability of the proposed mobile mapping application, and the feasibility of the proposed solution. Some of these applications are published in App Store.

Keywords: Location-based services, Ubiquitous Mapping, Georeferenced analog maps, Sustainable local tourism map ecosystem

1. Background

Tourism is an important application domain of Location-based Services (LBS), and most of the applications can be considered as *map-based LBS* (Gartner and Uhrlirz 2005; Raper et al. 2007). Current mobile LBS applications for tourism mainly utilize web mappings (e.g., Google Maps) as base maps for presenting location-related content bundled to points of interests (POIs). However, the current web mapping has limitations (Muehlenhaus 2014), as they lack diversity and freedom in map communication in terms of ubiquitous cartography (Gartner et al. 2007). On the other hand, various tourist-oriented maps can be found in the offline world, such as illustrated maps and hand-drawn maps in tourist guidebooks and free leaflets. Compared with current web mapping, the tourist maps in analog media are usually more contextual, as they are designed for certain user groups and areas in certain cultural backgrounds, and. However, due to the limitation of the analog media, the tourists using such maps cannot benefit from the location-aware digital environments.

According an investigation to the local tourism organizations in Tokyo, Japan, their tourist maps are usually created by map designers and printing companies according to the information collected by the organizations. The organizations are facing the financial pressure of managing the paper maps, and they found it difficult to get feedbacks from foreigners for improving the maps and services. They are willing to utilize the latest technologies for better use of their tourism resources with lower cost and better sustainability.

2. Sustainable local tourist map ecosystem with LBS

In the authors' prior research, a framework of Human-Centered Mobile Mapping (HCMM) was proposed to geo-enable the analog maps with georeferences and enrich them with multimedia content to provide LBS applications with a variety of maps (Lu and Arikawa 2013, 2015). A prototype named *Manpo* is developed as a realization of HCMM. Based on *Manpo*, the authors propose a low-cost solution of LBS tourism applications utilizing the existing analog maps of the tourism organizations, and attempt to establish a new ecosystem of local tourist maps for the sustainable development of local tourisms.

This ecosystem includes a platform and tools to georeference analog maps and integrate multimedia resources, mobile applications for users to browse the maps and content with positioning function, opt-in data donation mechanism to collect user-generated data and content, and analysis tools to generate feedbacks. It will involve the tourism organizations, tourists, designers, developers, analyzers, and so on.

3. Edit tools for analog map georeferencing

The current GIS software cannot provide enough support for georeferencing analog tourist maps and integrating sightseeing information resources, and are usually too complicated for the staff of local tourism organizations. New tools and processes need to be designed and developed considering the ease of use. The authors developed an experimental edit tool named *Manpo Editor*, and applied it in cooperation with local tourism organizations and college students in Tokyo. The main processes of editing the maps and content (called *Manpo Content*) mainly include data preparation, map content bundling and georeferencing.

The existing resources owned by the organizations should be digitalized and processed before edited by *Manpo Editor*. They may include the digital images of the tourist maps, the coordinates of the POIs and routes, texts, photos, audio clips, web links, and so on. These materials can be integrated using *Manpo Editor*. The main process is to input POIs as points on the import the map images, correspond them to geographic coordinates, and bundle the multimedia resources. The inputted maps, POIs, routes, and bundled media files are packaged with metadata, which describes the geometric and geographic information of the components on the maps and the bundled media files.

To enable location-based functions, the analog maps have to be georeferenced. This research applies control points that have corresponded geographic coordinates and graphic coordinates. All the POIs on the map images can be utilized as control points. *Manpo* has applied *TIN-based Affine Transformation*, to calculate the position on the map images with the nearby control points.

4. Design principles of mobile tourism applications with georeferenced maps and content

Different from the applications developed with the APIs of web mapping services, the architecture of applications like *Manpo* must consider the special data structure of georeferenced maps. The application must deal with the map visualization, positioning on maps and geo-event handling accompanying with user interactions. It can be composed by Content Data Module, Positioning Module, Log Data Module, Geo-event handler Module, Visualization Module, User Event Handler Module, and Data Donation Module.

In the mobile application with maps for tourists, different types of graphics and images are displayed together. Proper visual hierarchy is required for the users to obtain the information quickly and comfortably. In *Manpo*, the map view contains visual layers that can be divided into background (map image, graphics of tour routes and moving trajectory), foreground (icons of POIs, highlighted POIs and routes, user content and current location), and accessories (buttons, controls, frame, footer and header). In the background layers, the sizes and colors of the trajectories and route polylines should not disturb or confuse the content of the map image below them. In the foreground layers, icons and graphics should also have certain visual hierarchy. In the accessory layers, the components should take as little space as possible from the map view, while keeping the operability of the controls.

5. Experimental applications

In cooperation with college students, university campuses, and local tourism organizations, experimental applications are developed to evaluate the functionality and usability of the proposed mobile mapping application, and the feasibility of the proposed local tourist map ecosystem. Some of them have already been published to ordinary users. The details of the published apps can be found at <http://ubimap.csis.u-tokyo.ac.jp/manpoproject/>.

6. Future work

The current research mainly focused on the application part, and more effects are required on the methods and tools for analyzing the user-generated data and content to extract more useful knowledge for the local tourism organizations, in order to complete the ecosystem. In addition, in the current prototypes of edit tools for analog map georeferencing and content integration, most tasks are manual and labor intensive. Better usability, for example, semi-automatic georeferencing of the maps, which has already been studied on historical maps (Hohn et al. 2013; Budig and van Dijk 2015). Collaborative georeferencing with crowdsourcing (Fleet et al. 2012) should be studied and applied to involve more contributors in the ecosystem. Furthermore, the common functions realized in *Manpo* should be integrated in a software development kit (SDK) and opened to other developers, in order to develop more applications with richer content and functions.

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